Power Saving Microcontroller based Robotic Solar Tracking Mechanism

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ABSTRACT
This paper presents a solar panel that constantly face sun at 90^0 to produce maximum voltage, as solar panel can move from east - west and north – south according to the durational movement of the sun. The microcontroller is designed to move the solar panel in four quadrants and operates with gear mechanism. This paper documents power generation using solar energy that can be used for home/domestic purposes, by controlling the movement of solar panels in the direction of the availability of sun rays. Robotic vehicle mechanism is used to move to the location where the maximum brightness/intensity is present which involves energy saving by switching ON and switching OFF the lights, fans and TV automatically by measuring the intensity and temperature of the surroundings.

General Terms
Microcontroller (Atmel 89S52), KeilµVision.

Keywords
LDR, DC Motors and Drives, Comparator, LCD, Solar Panel and LED

1. INTRODUCTION
In this 21st century, we are seeing electric power problem everywhere due to shortage of power generation in power plant. Due to population growth, economic growth and technological growth the worldwide energy usage in the form of electricity is increased from last two decades. After the Second World War industrial revolution has been started and lead to large use of petroleum and coal. Over use of this fossil fuel leads to rise in environmental pollution, increase in price, shortage, global warming, etc. To overcome this problems to a certain limit scientists and researchers are giving more demand for renewable energy which is from natural resources such as sunlight, tide, wind, rain and geothermal energy[1]

Sun is the primary source of energy. Solar energy, radiant light and heat from the sun has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaic, solar thermal electricity and solar architecture which can make considerable contributions to solving some of the most urgent problems the world now faces. Sunlight reaches the earth in the form of solar radiation. Solar radiation received by planet earth is about 1.3 KWh/m²[2]. The earth receives 10^{16} MW unit of energy from the sun per day, which is 1,000 times the energy required for all mankind on the Earth. Some of the Solar Energy causes evaporation of water, leading to rains and creation of rivers etc. Some of it is utilized in photosynthesis which is essential for sustenance of life on earth. If 5% of this solar radiation is efficient utilized then it is 50 times more for worldwide energy consumption.

Photovoltaic is a method of generating electrical power by converting solar radiation into direct electricity using semiconductors that exhibits the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material [3]. To get maximum efficiency, the solar panels must remain in front of sun during the whole day. But due to rotation of earth those panels can't maintain their position always in front of sun. This problem results in decrease of their efficiency. Thus to get a constant output, an automated system is required which should be capable to constantly rotate the solar panel. The solar panel can be rotated a tiny desired angle. The dual-axis sun direction tracking system was made as a prototype to solve the problem, mentioned above.

2. PROPOSED SYSTEM
The existing system receives sun energy only for few hours, which is not economical when compared to cost of the system. Here the proposed system is designed to observe the sun for the available maximum hours, for example – 12hours a day. The solar panel is designed to constantly face sun at 90^0 to produce maximum voltage. The automated system controlled by a microcontroller can able to move the solar panel at four quadrant direction; east, west, north and south for the durational movement of the sun in the sky. The set of light dependent resistors (LDR) give input to the control system and it operates DC motor with gear mechanism as shown in Fig 1.

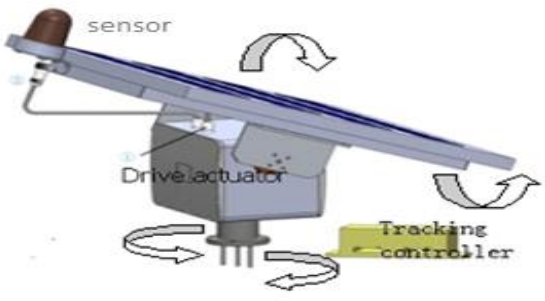

Fig 1: Concept of Dual-axis sun direction tracking for solar panel

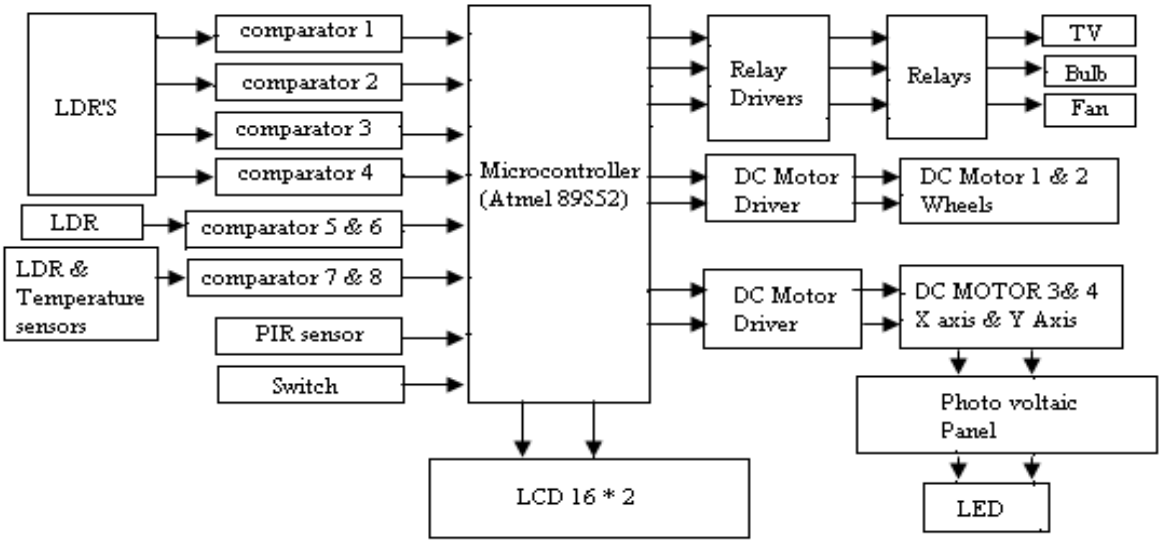

Fig 2: Functional block diagram

3. BLOCK DIAGRAM & WORKING

3.1 Block Diagram

The functional block diagram of proposed system is shown in fig 2. 8-bit Microcontroller (Atmel 89S52) controls the peripherals. Among the two DC motor one will have X-axis control and another will have Y-axis. Four Light Dependent Resistors (LDR) sense the light intensity from the solar radiation. Each of those will be placed in each direction (east-west, north-south) and these sensors output is connected to comparator, which will compare the light intensity and gives its output to microcontroller. From these comparator output controller will decide in which direction the sun is moving and in the same direction it starts moving the solar panel with the help of DC motors. LED which will glow by the intensity of the solar panel to indicate whether the solar cell works properly.

3.2 Working

A basic two-axis tracker that uses a vertical axis, driven by a small DC drive motor, and an elevation axis driven by a linear actuator, often called a screwjack, which extends and retracts like a long piston to raise and lower the panel with respect to the current azimuth position. There is a substantial variety of two-axis trackers in operation. Each shares the ability to point directly at the sun throughout each day all year long. A four quadrant tracker uses a vertical and horizontal axis is driven by a pair of small. DC drive motors, each motor plays a key role in rotating the solar panel so that it is always perpendicular throughout the day and even through the year, because the sun changes its angle of rising and setting every month or two by an angle of 15 degree called declination angle.

4. IMPLIMENTATION

The implemented hardware part is shown in fig 3. This involves a Robotic vehicle on which the whole system of motors, solar panel, PCB boards are placed. The Robotic vehicle moves to and fro and adjusts itself where the maximum intensity is available so that more efficiency is obtained. PIR sensor which will monitor whether somebody is in front of the TV or not and if no one is present then it automatically turns OFF and to switch ON the TV and the LDR and temperature sensor is used where by this controller gets to know how much the room light and temperature density will be[4]. And those will be controlled automatically according to the condition in the room.

Keilμ Vision software is used to develop the program using embedded C language.

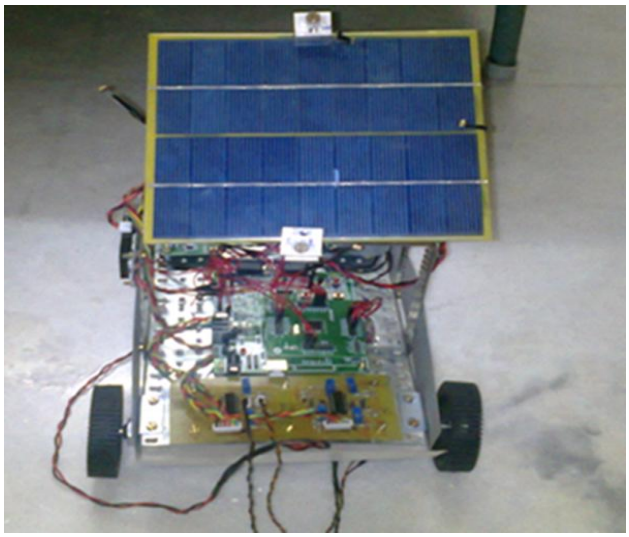

Fig 3: Hardware model

5. RESULT

The Result obtained for stand still position of solar panel, for two quadrant rotation , for four quadrant rotation and with the robotic vehicle rotation is as tabulates in the below table 1,2,3.

Table 1: Standstill Position

Time	Voltage (V)	Current (mA)	Power (mW)
06 am	2.4	0.1	0.24
08 am	5.8	0.13	0.75

10 am	6.5	0.21	1.36
12 noon	7.7	0.34	2.618
02 pm	8.6	0.53	4.558
04 pm	7.6	0.25	1.925
06 pm	4.0	0.03	0.12

Table 2: Two Quadrants Rotation

Time	Voltage (V)	Current (mA)	Power (mW)
06 am	3.6	0.09	0.302
08 am	8.96	0.2	1.32
10 am	7.8	0.25	1.95
12 noon	9.3	0.38	3.534
02 pm	10.32	0.65	6.708
04 pm	9.42	0.3	2.82
06 pm	5.54	0.05	0.277

The table 2 shows the output of the panel which is rotating in two quadrants that is from east to west direction. In this 2-quadrant operation the efficiency increases by 15-20% compared to the stand still position of table I.

Table 3: Four Quadrants Rotation

Time	Voltage (V)	Current (mA)	Power (mW)
06 am	3.92	0.1	0.392
08 am	8.26	0.25	2.065
10 am	9.1	0.3	2.73
12 noon	10.9	0.45	4.905
02 pm	12.04	0.78	9.312
04 pm	10.96	0.4	4.384
06 pm	6.63	0.07	0.464

The table 3 shows, the output of the panel rotating in four quadrants from east to west and north-south and the panel rotates in such a way that the panel faces sun at 90^0 always. This way the efficiency of power produced increases even more.

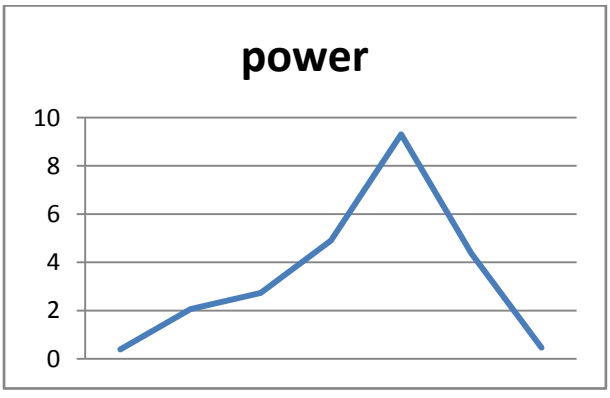

Fig4: graph of power v/s time in rotation with Robotic vehicle

The robotic vehicle is used to move the panel and capture maximum sun rays falling on to the panel. If there are any chances of shadow falling on the panel, then the panel adjusts itself and prevents the shadow falling on the solar panel. By this the output obtained is even more increased as compared in the tables1,2,3 and the same is indicated by graph fig4.

6. CONCLUSION

It is possible to improve the amount of energy obtained from conventional sun direction tracking system by using microcontroller based Sun direction tracking system here, initially we increased efficiency from 10-15% using two-quadrant system. Secondly, by using four-quadrant system we increased the efficiency 70-75%. Finally, by using a Robotic vehicle the efficiency reached approximately to 80-85%. By using LDR's, comparators and relays the energy inside the house is saved efficiently. The DC motors are used instead of mechanical gears to rotate the solar panel. So that the weight of the motors will not affect the model and rotation. This system can be used for industrial applications and commercial applications such as implementing panels on vehicle rooftops, household applications to limit the industrial electricity usage under good climatic conditions.

7. ACKNOWLEDGMENT

7.1: Solar panel which we use produces a DC voltage but there are panels which can directly produce AC voltage which are called as Micro inverter panel

7.2: We can fit wipers to the panels so that regular cleaning of panel is done automatically and by this even the efficiency can be increased by 2-5%.

7.3: Study must be done on how to clean very large panels regularly. Because the dust and other particles can reduce the efficiency of the panels and cleaning such type of panels daily is a big task

8. REFERENCES

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